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Title:	NHMFL Pulsed Field Facility Capabilites Overview
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Intended for:	For use it conversations with other scientists
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NHMFL Pulsed Field Facility Capabilites Overview

James Wampler, Vivien Zapf

Los Alamos National Laboratory (LANL)

NATIONAL HIGH MAGNETIC FIELD LABORATORY

Outline:

1. Magnets
2. Probes
3. Process

3N070A

1. Four (4) 65 T Magnets
2. 75 T Magnet
3. Mid Pulse magnet
4. 100 T Magnet in… soon?

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A User Facility:

Magnetization
Resistivity
Electric polarization/dielectric
Magnetostriction
Magnetocaloric
dHvα, sdH: fermi surface
Tunnel-diode oscillators: rf penetration depth
Optical absorption

Credit : Vivien Zapf

- Include 73 T and mid pulse
- include pic of generator in the warehouse

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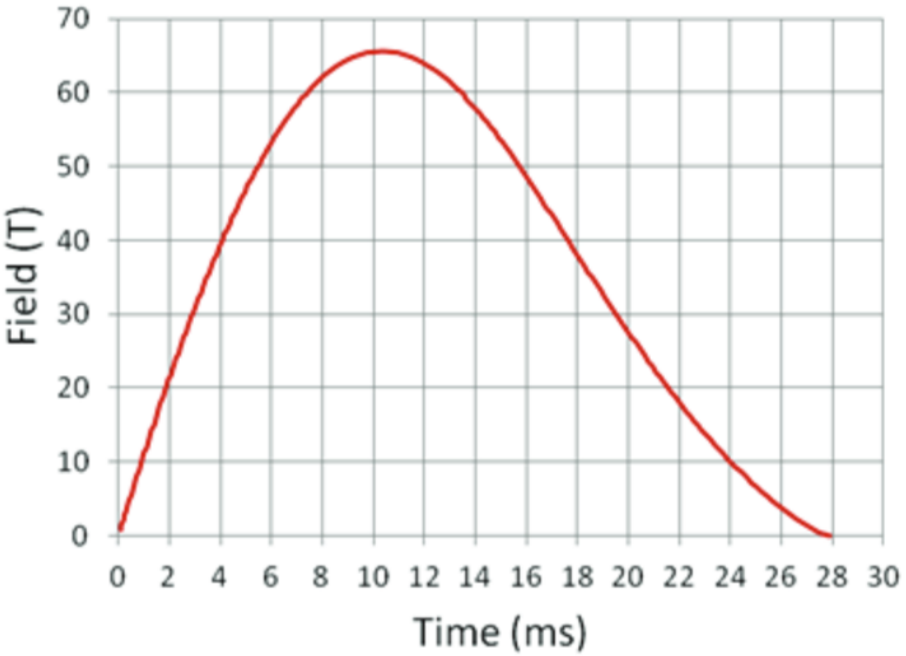
Four (4) 65 T Magnets



Capacitor bank ~ 4 MJ

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73 T Magnet

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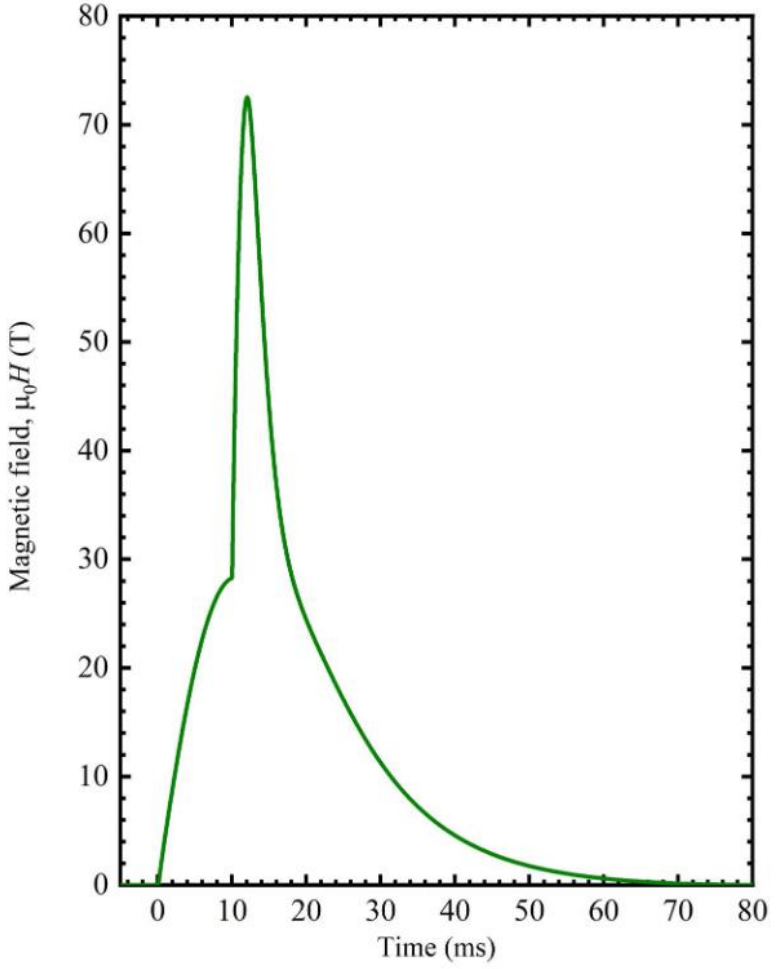

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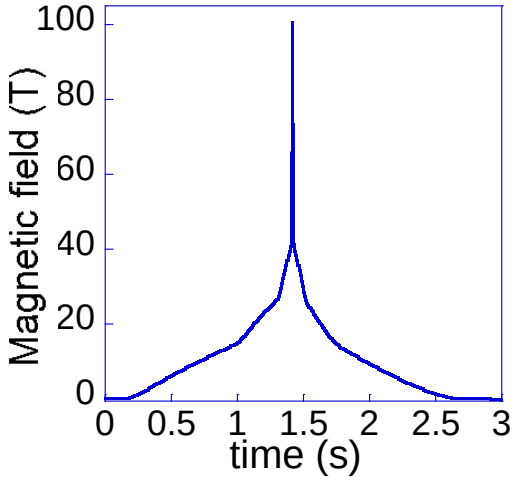
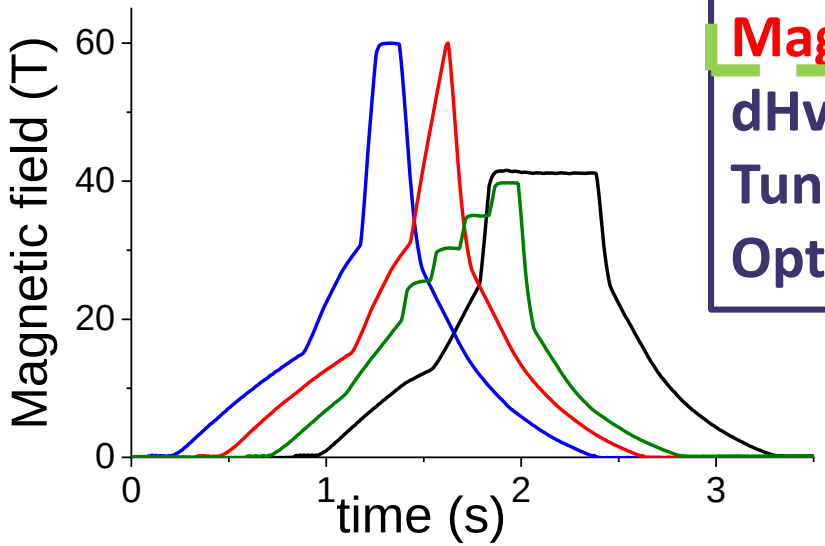
101 Tesla multishot (*world record*)



60 Tesla long pulse (*world record*)



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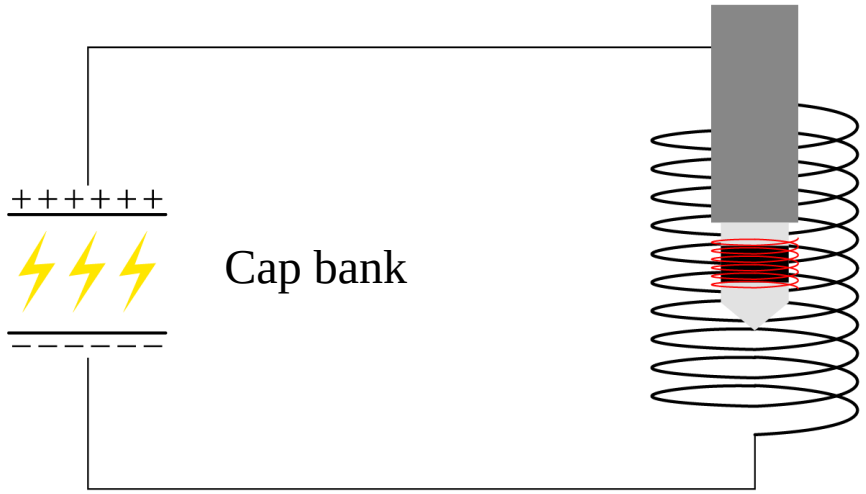
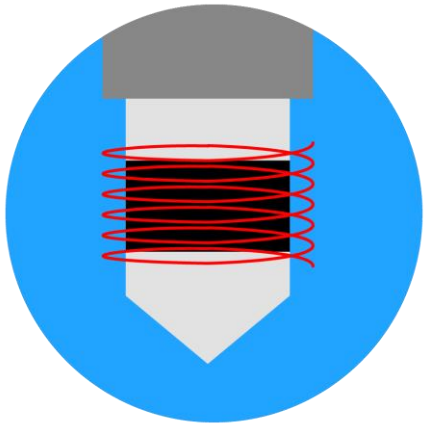
High Field Magnetization



Black line : Magnet



Black: **Sample Cylinder – 1 mm inner diameter, 5 mm length.**

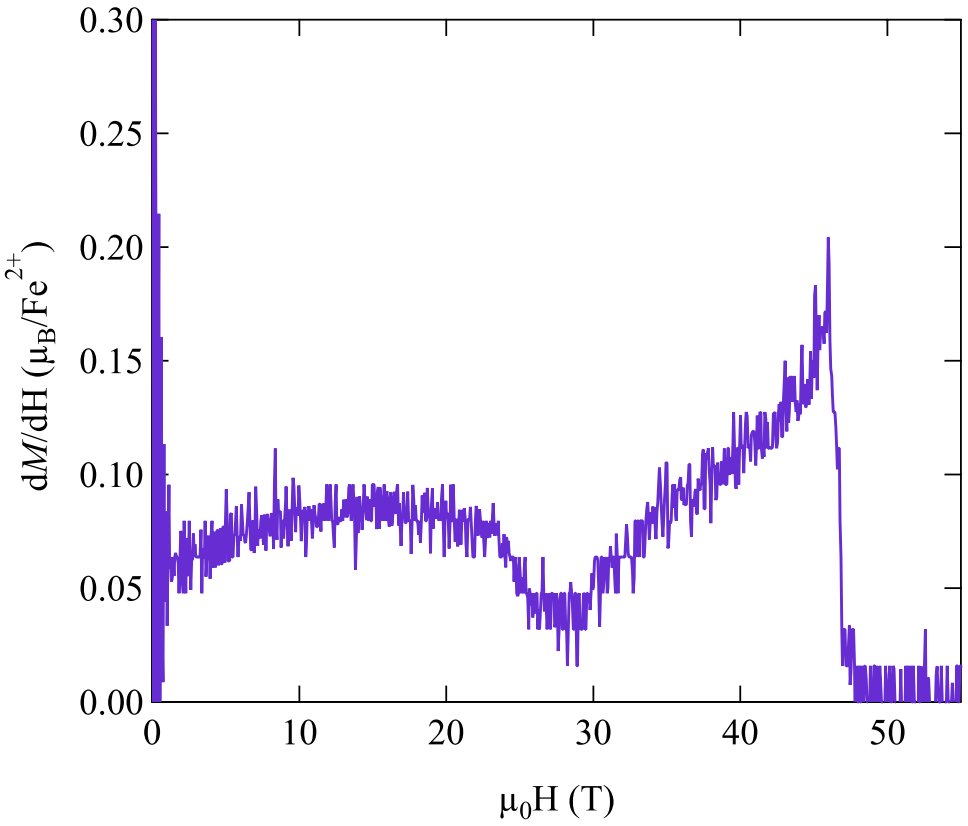
- Sample must be held still through N Grease or similar

Red: Pickup coil – Cu - 1000 turns (CCW) + 500 (CW) + one turn of compensation coil

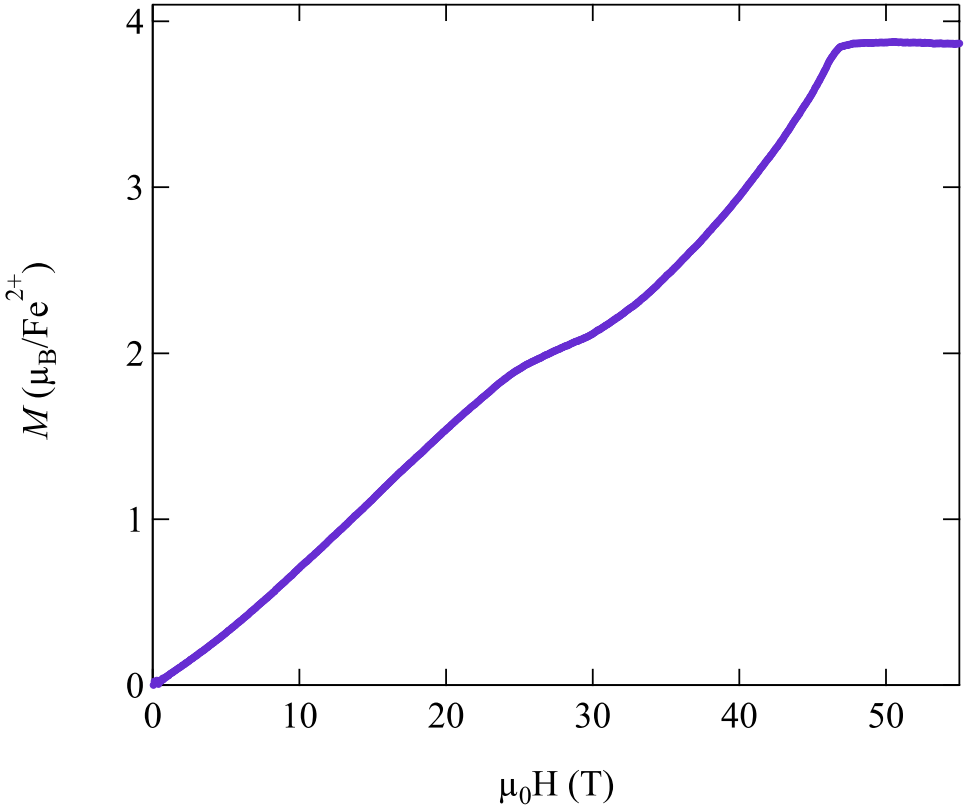
- Measurement : voltage across the pickup coil $\propto \frac{dM}{dH}$.
- Integrate $\frac{dM}{dH}$ with field to obtain the magnetization.

Minimum temperature: ~0.6 K

High Field Magnetization

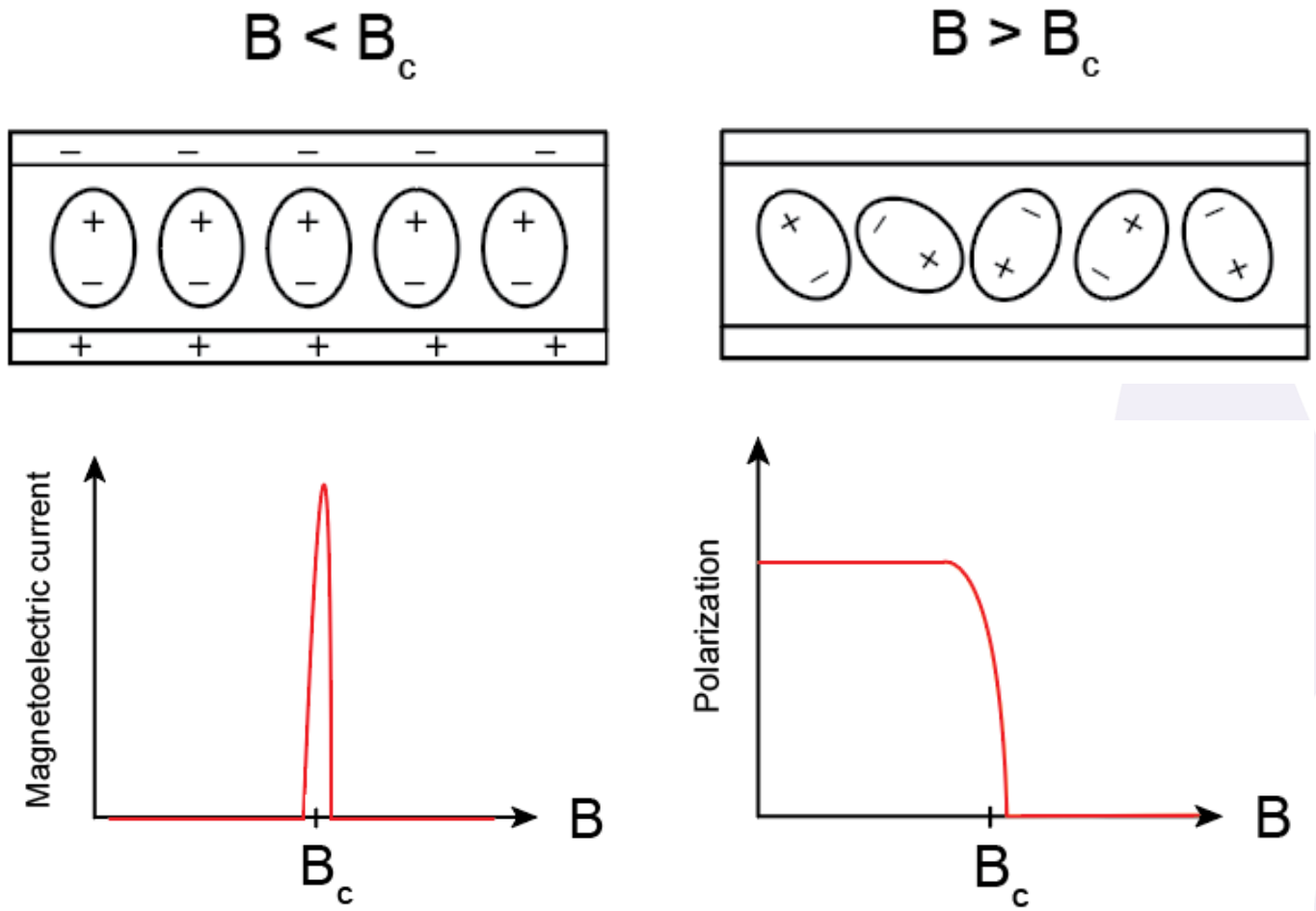


Raw data



Integrated magnetization data

High field Polarization



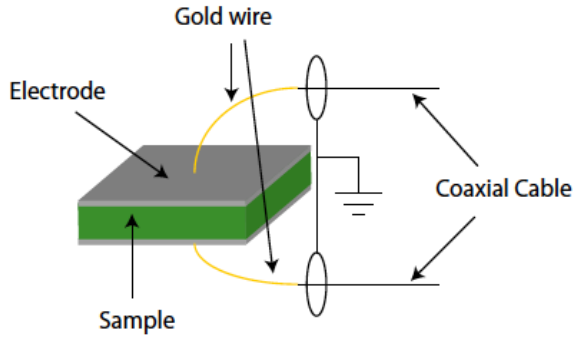
Samples must be insulating

We measure I_{me} and integrate with time to obtain the change of polarization

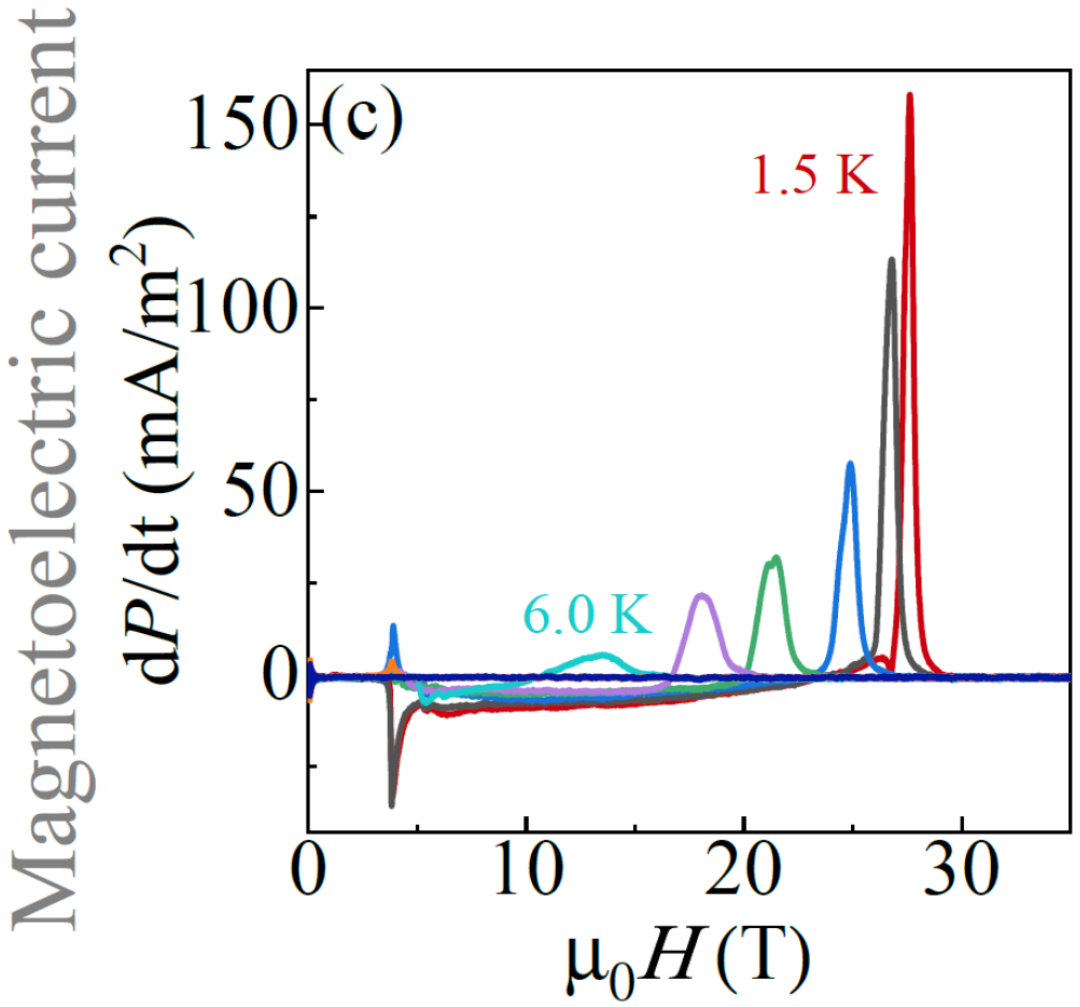
$$Q = \int I_{me}\, dt$$

$$\frac{dQ}{dt} = \frac{dQ}{dB}\frac{dB}{dt} = I_{me}$$

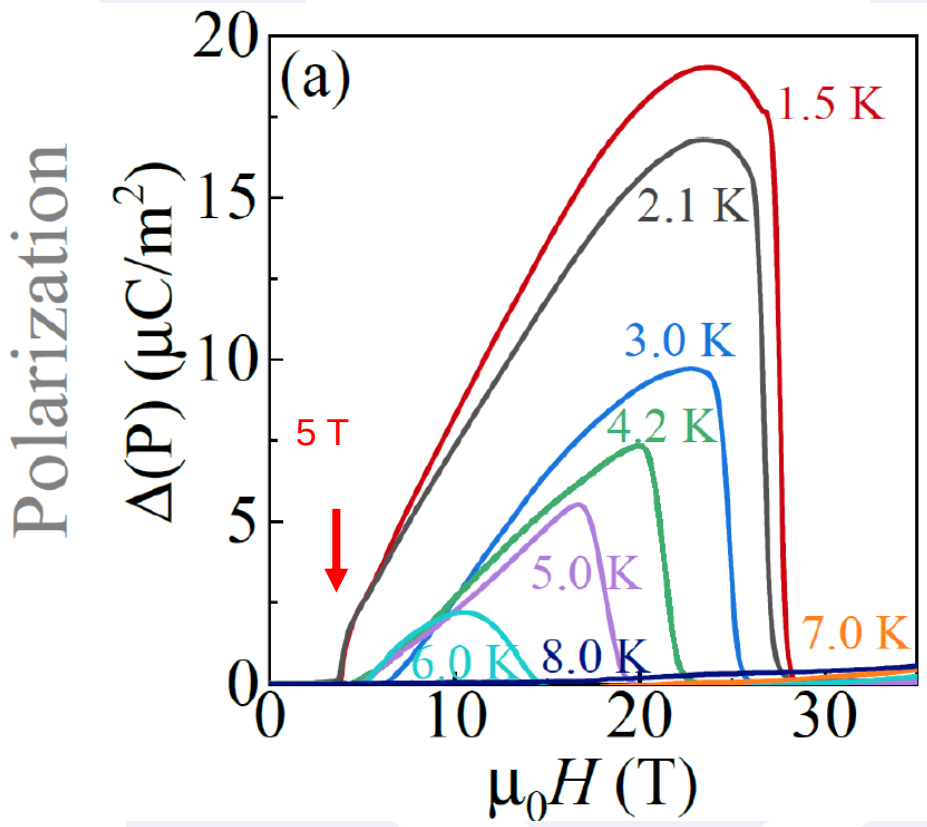
Current is proportional to dB/dt -> faster field sweep rate increases the signal size!



High field Polarization



Raw data



Integrated delta P data

Polarization Sample Prep

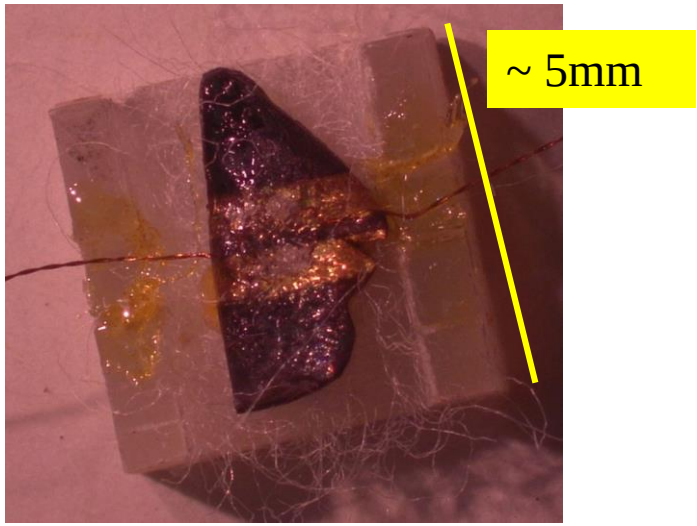
- Sample must be insulating (> TOhm)
- ~1 pA minimum signal
  - Current depends on size of surface, so big pads is good.
- Flat bulk or thin film – two well defined surfaces
  - Multilayer for bottom lead or some other way of accomplishing that
  - Electrodes on both sides
- Au or Pt wires
- Can measure 2 samples simultaneously; 1 in plane, 1 out of plane
- 5 mm^2 max
- <2 mm

Magnetocaloric effect

- Measuring temperature change of sample as a function of field in the adiabatic condition.

AuGe: Semiconductor – Thermometer.

Au: Electrical Contact

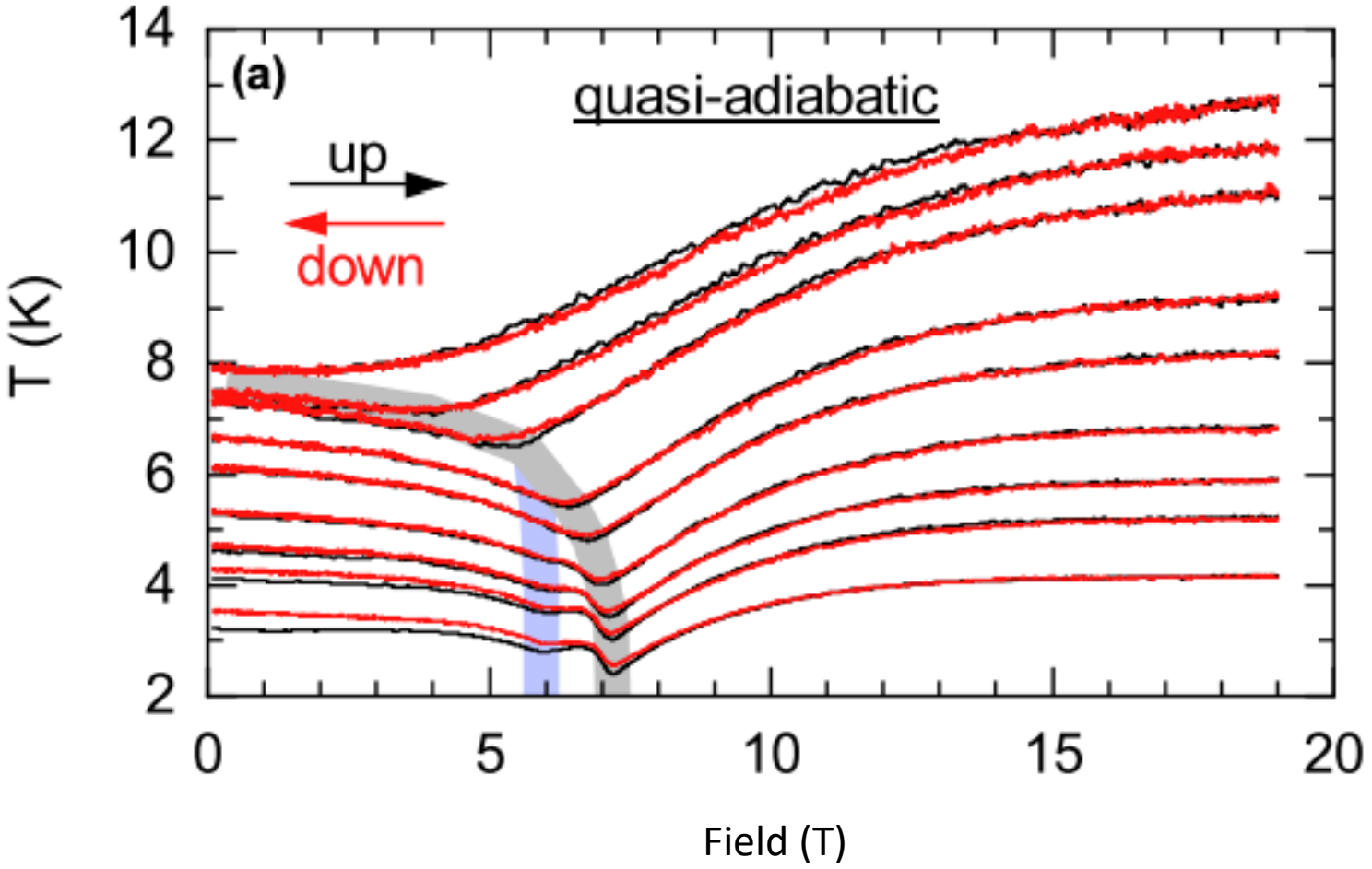


Picture of α-$RuCl_3$

Measure resistance of AuGe - > Convert it to temperature.
(Can also measure resistance and not convert to temperature!)

- Can sputter on the contacts at LANL or at UCSD
- Same technique used to measure AC resistivity
  - AuGe not necessary
- 1 MΩ practical limitation

Magnetocaloric effect – example data



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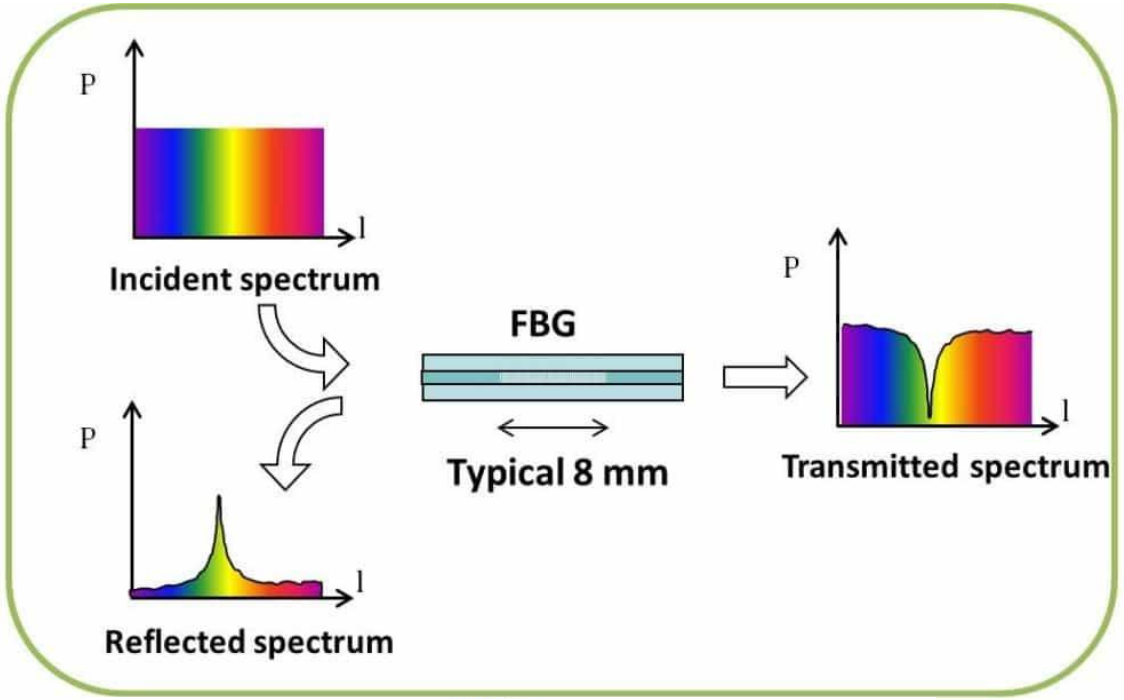
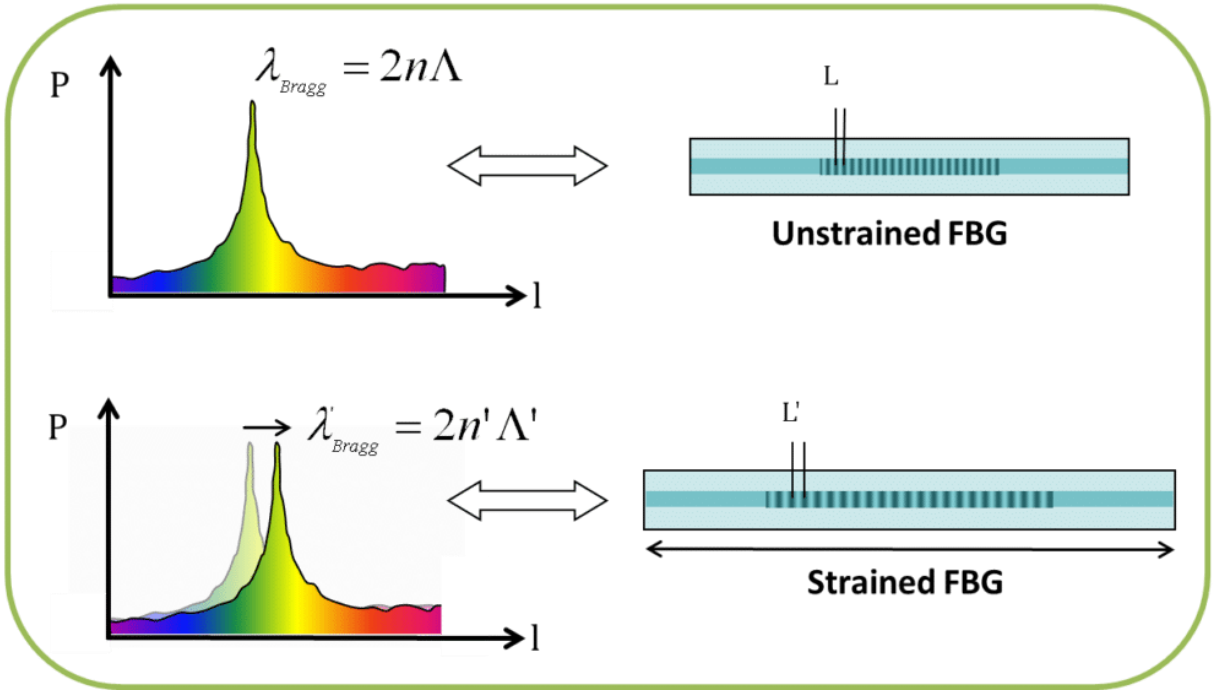
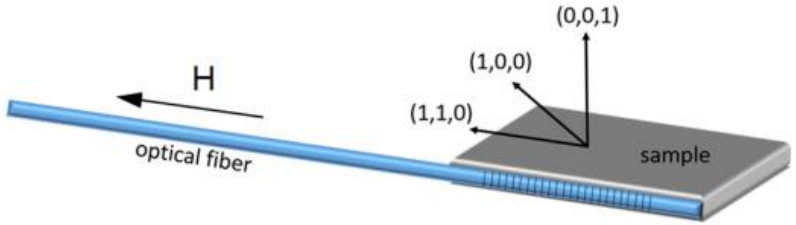
High Field Magnetostriction

Limitation: Mostly only useful for bulk samples!

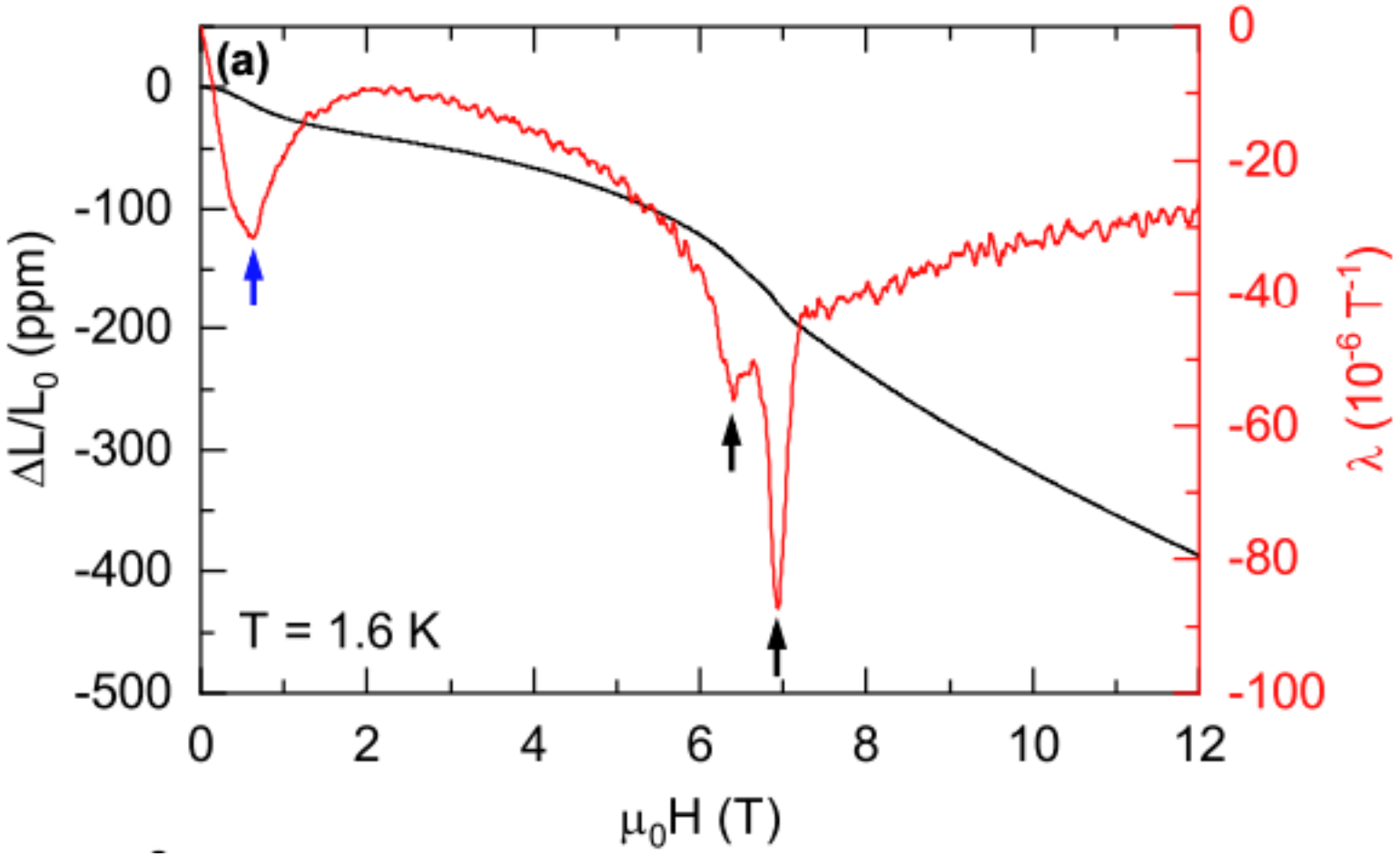


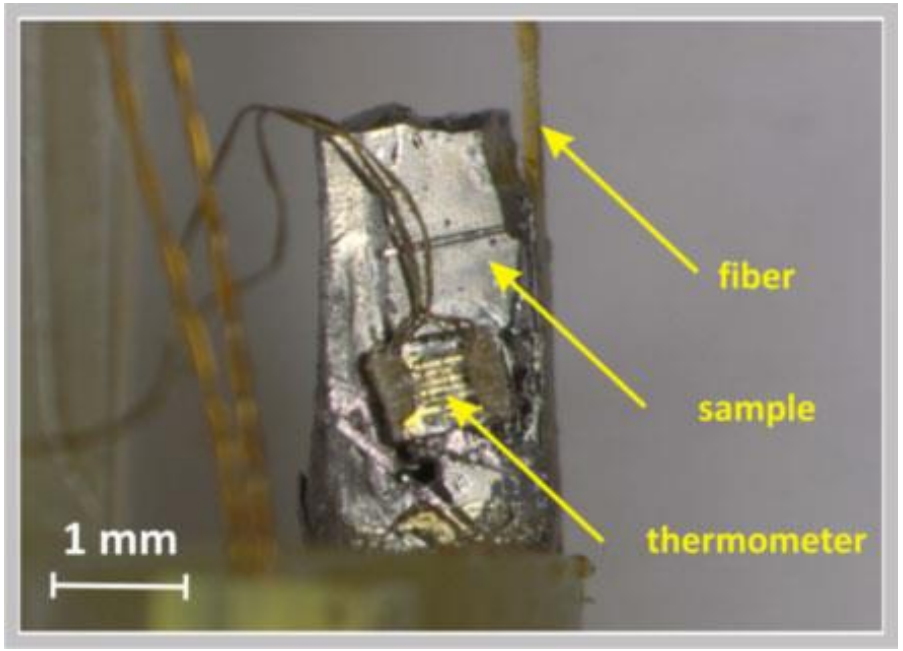




Credit : fbgs.com

High Field Magnetostriction – example data





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Applying for magnet time

- The Pulsed Field Facility (part of the NHMFL) is a user lab
- 3 page long proposal covering the proposed science and impact
- 1 page long experimental proposal covering the experiment and prior work
- Deadlines are rolling – announced as we approach
  - Submit any time
  - Next deadline Nov 12, 2021
- I am happy to support your magnet times

https://nationalmaglab.org/user-resources/request-magnet-time

Maglab in the time of Covid

- Only vaccinated individuals may visit the lab
  - Non-US residents require additional testing upon arrival
- NM very safe. Los Alamos is particularly safe.
  - LANL has a vaccine mandate effective Oct 15
- Flying still risky. 14 hour drive still lengthy.
- Since you are applying for time well in advance, there's always unknowns.